

of the butadiene. The diblock arms thus formed were analyzed by refractive index and found to be 46% by weight styrene and 54% butadiene. The diblock arms had M_n of 86,000. There was then added 14.7 g. of divinylbenzene of 55% purity (6.1 DVB/RLi) and the whole was held for 1-2 hours at 70° C. to complete the linking reaction. M_n was 931,000 for the star-block copolymer at this point of the reaction. This indicates that the star-block copolymers had about 10.8 arms per molecule. At this point, there remained one active lithium site at the nucleus of the copolymer for each arm attached thereto, as indicated by the red-brown color of the solution. Gaseous carbon dioxide was introduced into the reactor and allowed to react for about 3 minutes, or until the solution was colorless. The resulting polymer was terminated by the addition of 2 ml. of a 1:1 mixture of hydrochloric acid (38% solution); isopropyl alcohol. The polymer was stabilized with 0.5 part of 2,6-di-tert-butyl-4-methylphenol per 100 parts by weight of polymer. This carboxylated polymer was designated base elastomer I. A control sample was prepared as above except, instead of adding the carbon dioxide, the polymer was terminated by the addition of methanol to form the control having no carboxyl groups.

Additional elastomers were prepared by the above method except that, instead of adding the carbon dioxide, in one case 5 mls ethylene oxide was added and in another case 5 mls of propylene oxide was added. The derivatized samples were designated elastomer IEO and elastomer IPO respectively. Although the functional groups in IPO is designated "Secondary alcohol" in Table I, it will be recognized that the addition of propylene oxide probably gives a mixture of primary and secondary alcohol groups.

Oil extended elastomer was prepared using 50 parts of Shellflex 371 oil per 100 parts of each of the neat star-block polymers. These were then used in a hard unit sole type formulation as follows:

Ingredient	Parts (by weight)
Oil extended elastomer	100.0
Shellflex 371 oil	60.5
Crystal Polystyrene	15.5
Resin 18-290	15.2
Hi-Sil 233	20.0
Irganox 1010	0.3
DLTDP	0.2
Tinuvin P	0.3

The crystal polystyrene was Cosden 500S, a low molecular weight polystyrene sold by Cosden Oil & Chemical Company. Resin 18-290 is a low molecular weight polyalpha-methylstyrene sold by Amoco Oil Company. The Tinuvin P is hydroxymethylphenyl benzotriazole, a stabilizer against ultraviolet light sold by Ciba-Geigy. Hi-Sil 233 is an amorphous silica sold by PPG Industries. Irganox 1010 is a hindered phenol antioxidant sold by Ciba-Geigy. DLTDP is the stabilizer, dilaurylthiodipropionate, sold by Cincinnati Milacron. Comparison of the hard unit sole compounds is shown in Table I.

TABLE I

Functional Group	Melt Index Cond E. (g/10 min)	Lorenzin Screw (amps)
Carboxylic Acid (Sample I)	18	28
Primary Alcohol	13	22
Secondary Alcohol (Sample IPO)	10	22
Control	5	32-34

The increased processibility of the compound made with derivatized elastomer is shown by the increased melt index and the reduction in amperage needed to process the compounds in a screw extruder at 350° F. and 250 rpm in the Lorenzin B-1 extruder. Other properties (measured but not shown) which were essentially unchanged by the carboxyl and hydroxyl groups were Shore A hardness, Ross Flex values, Taber Wear, abrasion results, tensile strength and elongation at break.

EXAMPLE II

The procedure of Example I was repeated up to the point of the addition of carbon dioxide. Instead of CO₂, 6.2 g. of octamethyltetrasiloxane was added to the un-terminated star-block copolymer. The product was an 11-armed star-block copolymer having 46% by weight styrene and 54% by weight butadiene. The M_n was 963,000 for the star-block and each arm was made up of polystyrene blocks of M_n 33,100 and polybutadiene blocks of M_n 54,700. The functional groups were siloxanol groups of formula $-\text{Si}(\text{CH}_3)_2\text{O}_2\text{H}$.

Footwear compounds formulated with this star-block copolymer will have greater processibility and adhesion to shoe uppers than those made with un-derivatized copolymers.

We claim:

1. A shoe-sole composition having greater processibility and adhesion to shoe uppers than composition made with un-derivatized copolymers consisting of:

- 100 parts by weight of a star-block copolymer of 10 to 55% by weight of a monovinyl aromatic monomer and 45 to 90% by weight of a conjugated diene monomer of 4 to 8 carbon atoms; said copolymer having at least three arms connected to a polyvinyl aromatic compound nucleus and polar functional groups attached to said nucleus by reacting a derivatization agent directly at the nucleus;
- about 80-250 parts by weight of a naphthenic extender oil;
- about 40-150 parts by weight of a polystyrene material selected from the group consisting of low molecular weight polystyrene, low molecular weight poly-alpha-methylstyrene, and mixtures thereof;
- about 0-80 parts by weight of a finely divided filler; and
- about 0-50 parts by weight of stabilizers.

2. The composition of claim 1 wherein said polar functional groups are selected from the group consisting of carboxyl, mercaptothiocarbonyl, sulfinio, primary alcohols, secondary alcohols, tertiary alcohols, halides, epoxide, silane, phosphine, phosphorus halides, carbonyl chloride, anilines, alkyl amines, mercaptans, ketones, aldehydes, carboxylic acid amides, N-alkyl amides, isocyanates, sulfonyl halides, haloformates, and siloxanols.

3. The composition of claim 1 wherein said star-block copolymer is a copolymer of styrene and 1,3-butadiene.

4. The composition of claim 1 wherein said finely divided filler is amorphous silica.

5. A shoe-sole having the composition of claim 1.

* * * * *